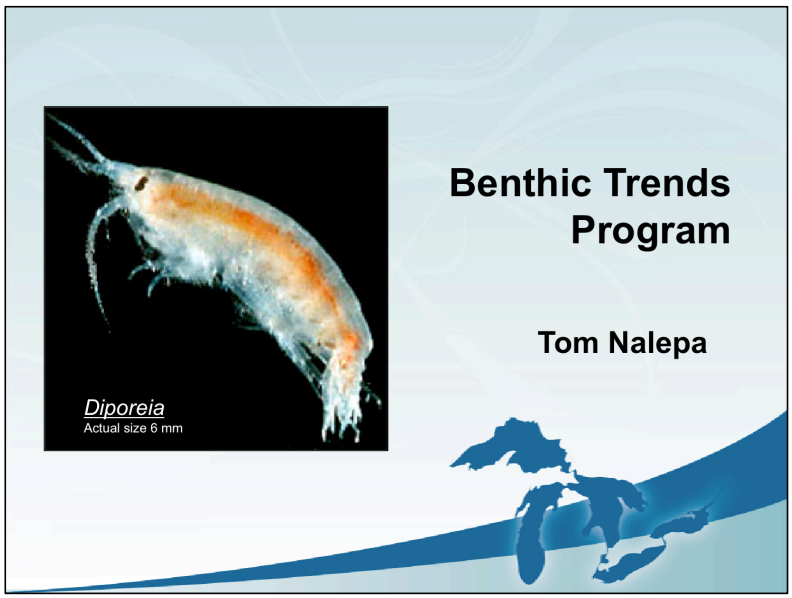
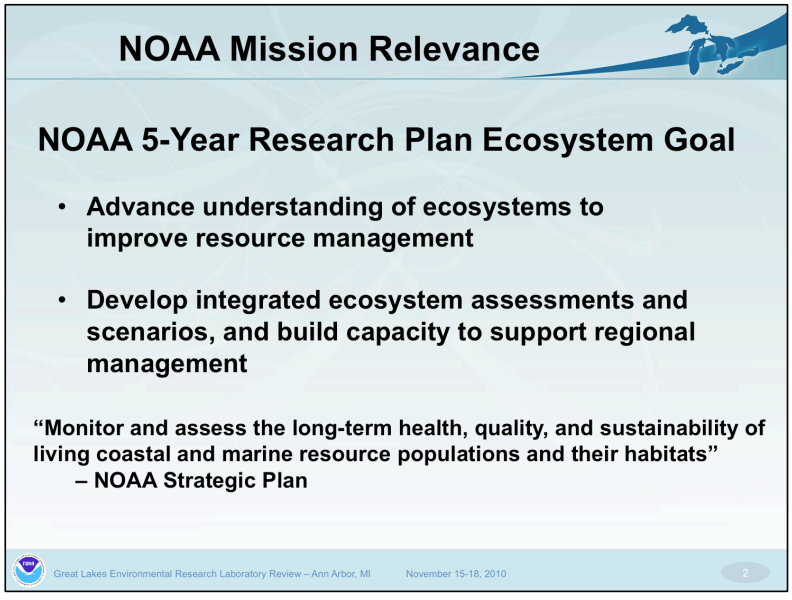


GLERL Benthic Trends Program was established in 1980.



Our efforts to assess long-term trends in benthic populations are consistent with the NOAA Strategic Plan, the NOAA Research Plan Ecosystem Goal, and other programs within NOAA, in particular the NOAA National Status and Trends Program which - "Was initiated to determine the health of the waters found along our coastlines and in our estuaries …. and to determine whether efforts to improve waters are having any effect."

Key Message: The GLERL program is driven by the NOAA Strategic Plan and is consistent with the NOAA National Status and Trends Program.

Benthic Program Guiding Principles

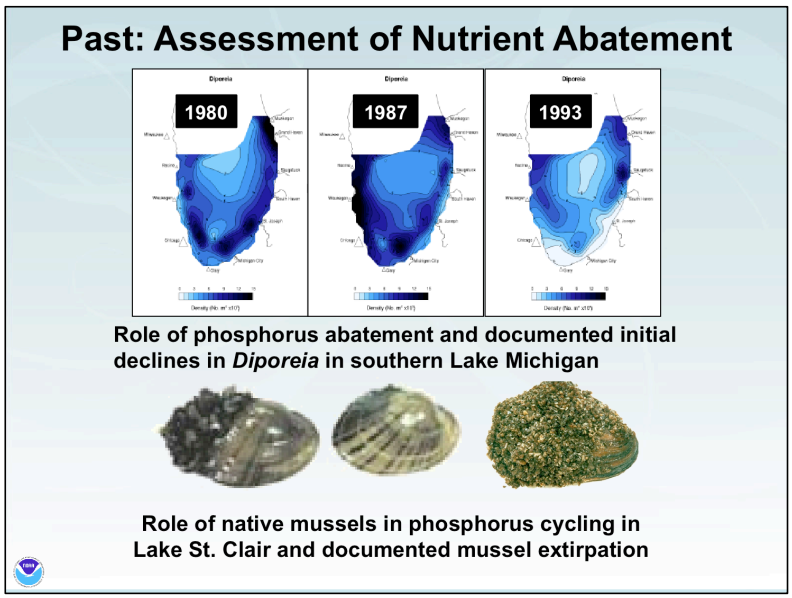
Goal: Assess trends in benthic macroinvertebrate communities as an indicator of environmental health

- **Collect and process data in a timely manner; partner with other organizations when necessary**
- **Publish raw data**
- **Identify organisms to the lowest taxonomic level possible**

Why assess trends in benthic organisms?

- **Indicators of ecosystem health**
- **Important component of food web**
- **Influence physical/chemical environment**

Indicators of ecosystem health – Benthic organisms integrate and reflect changes in both sediments and water column.
Important component of food web - Serve as a pathway by which energy is cycled from lower (phytoplankton) to upper trophic levels (fish)
Influence physical/chemical environment - Re-mineralize and excrete nutrients, bioaccummulate contaminants, and influence exchange between sediments and overlying waters (bioturbation)



Program History – The benthic monitoring program was originally started to assess responses to nutrient (phosphorus) abatement programs and to determine roles in nutrient cycling. We did not know it at the time, but these early studies provided the basis for assessing the huge impacts of dreissenid mussels.

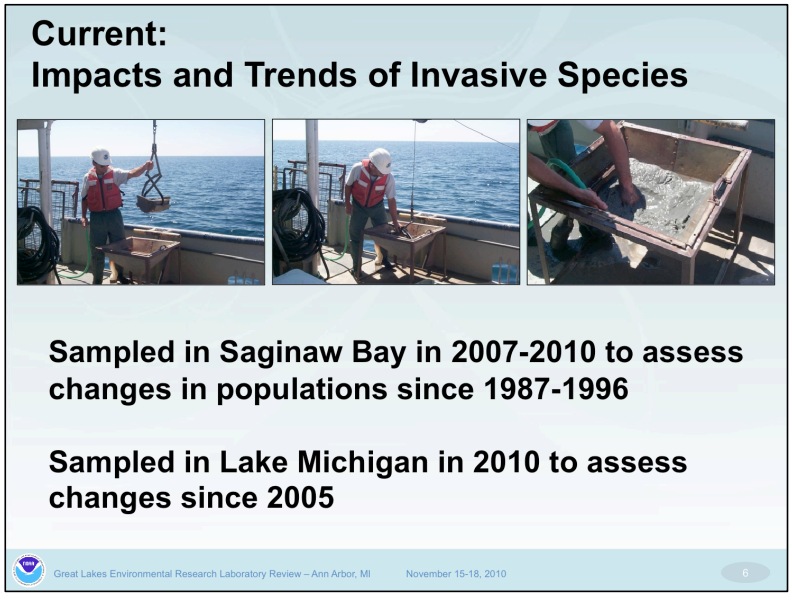
Nutrient Abatement:
Southern Lake MI sampling: 1980-2008
Lake Huron sampling: 2000-2007
Saginaw Bay sampling: 1987 - 1996

Extirpation of Native Mussels:
Sampling 1986-1996

Power of Monitoring: Provides baseline data

Leverage Past to Future: Yesterday's data, today's data, tomorrow, e.g. climate change

5



Presently, we continue to assess impacts of dreissenids.

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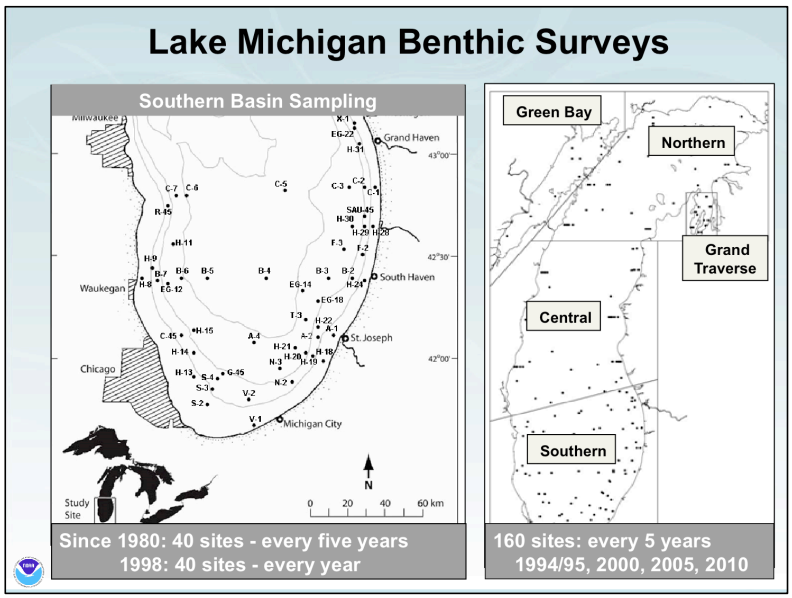
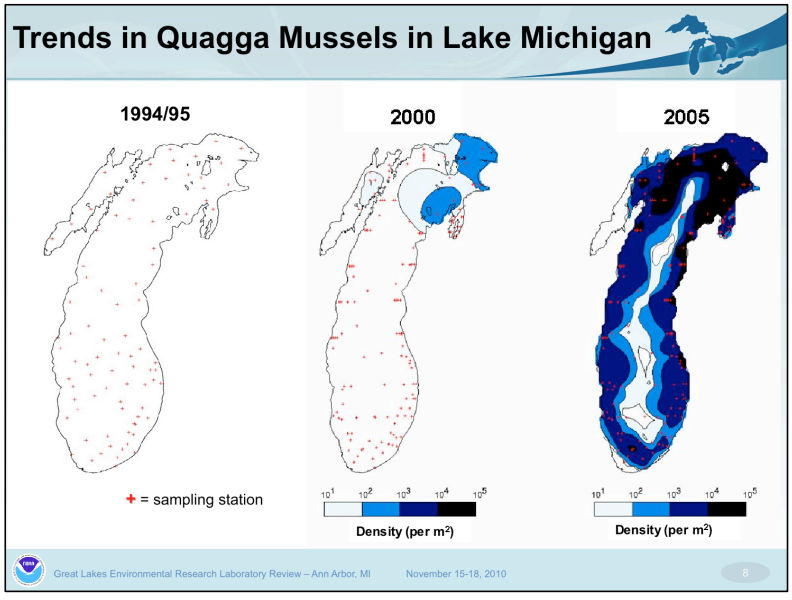
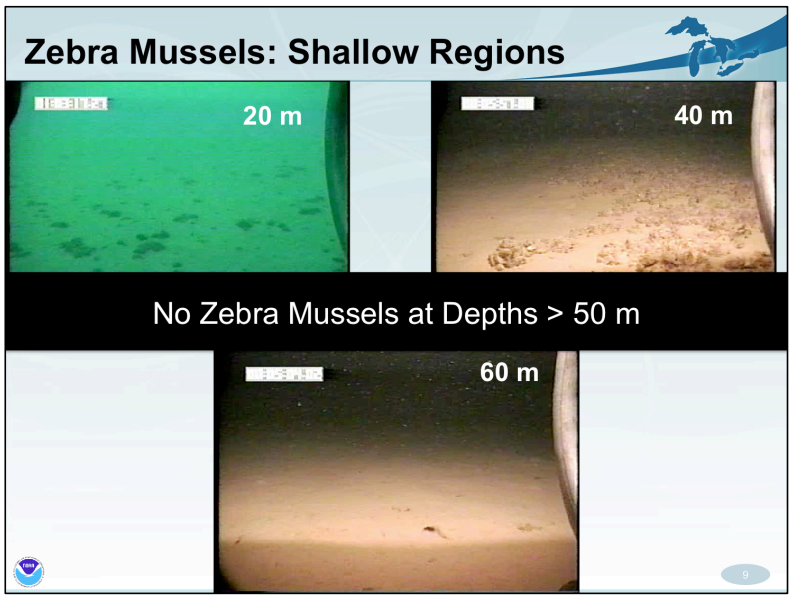


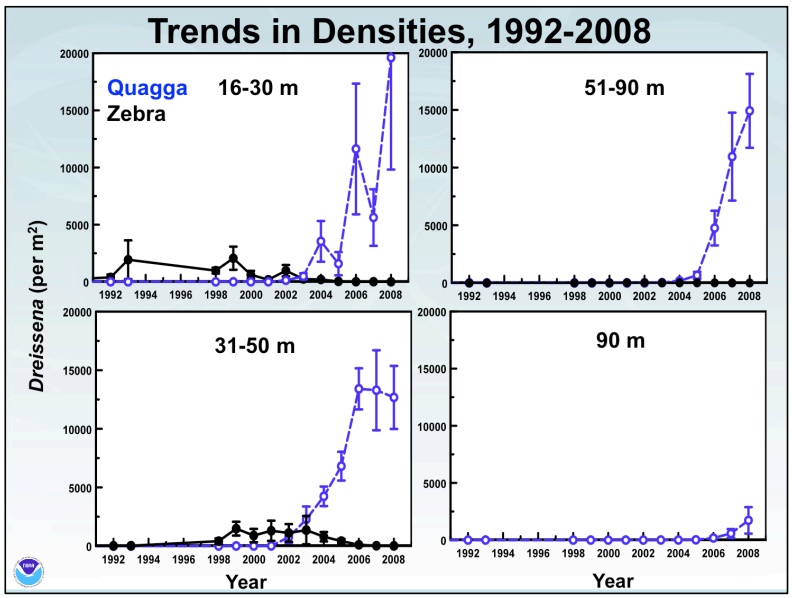
The most intensive, ongoing surveys have been conducted in Lake Michigan.



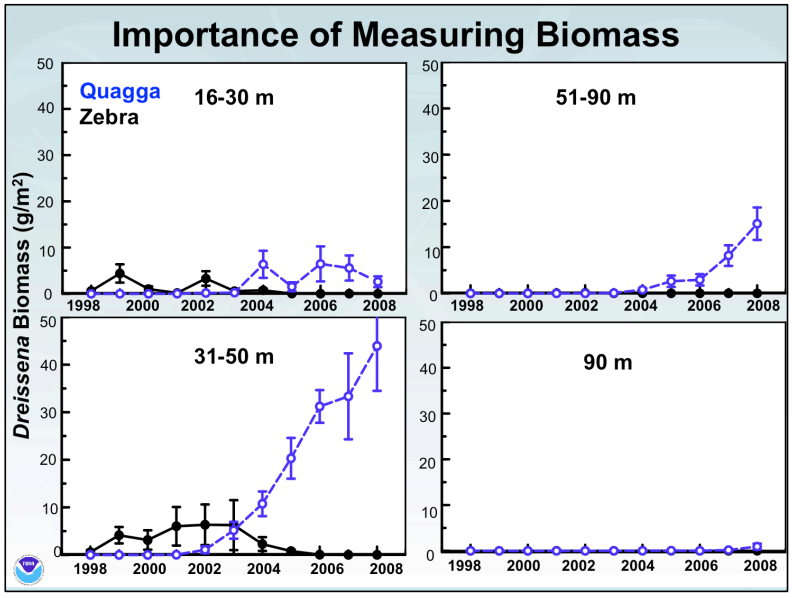
We were able to document the Quagga mussel population explosion in Lake Michigan between 1995 and 2005.



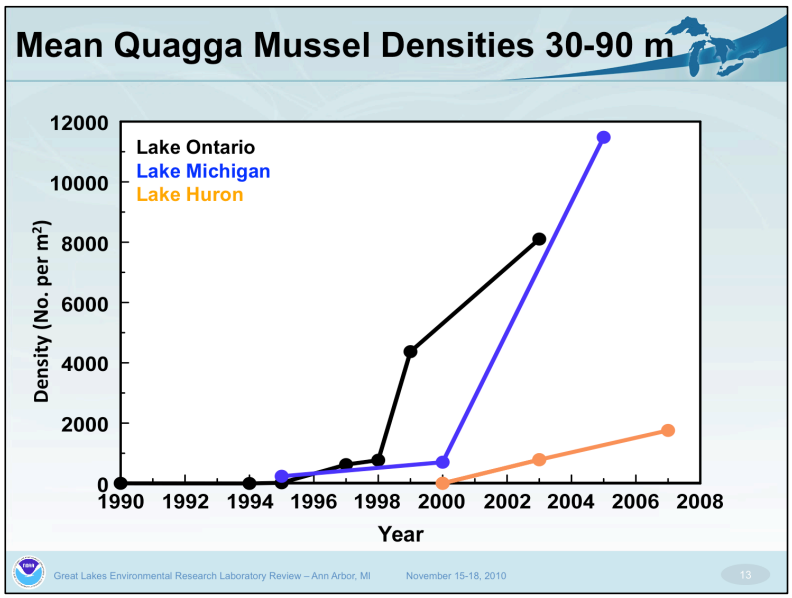
No Zebra mussels found at depths greater than 50 m.



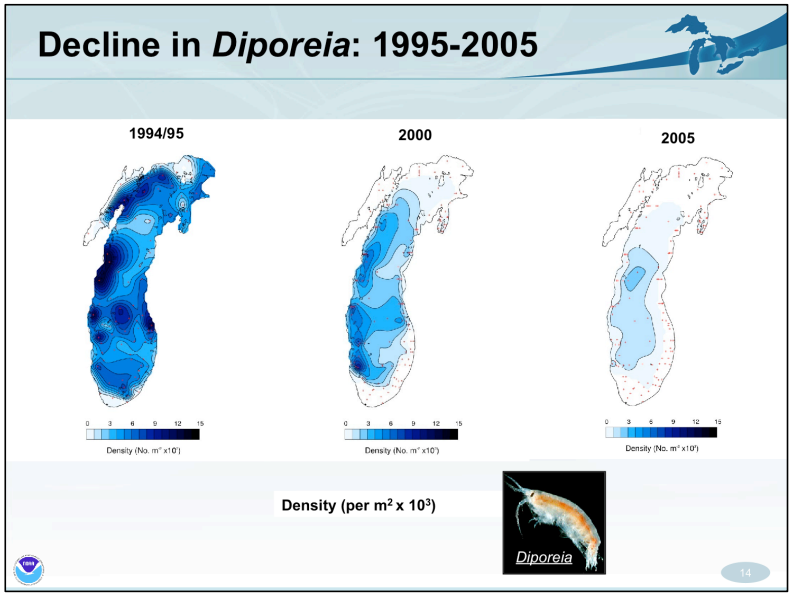
Quagga mussels are now more abundant than Zebra mussels ever were in shallow regions (< 50 m), and are colonizing deeper regions (> 50 m) where Zebra mussels were never found. Quagga mussels have a lower respiration rate and a higher assimilation efficiency compared to Zebra mussels and can reproduce at the cold temperatures found at deeper depths. The Quagga population has not yet stabilized, still growing.



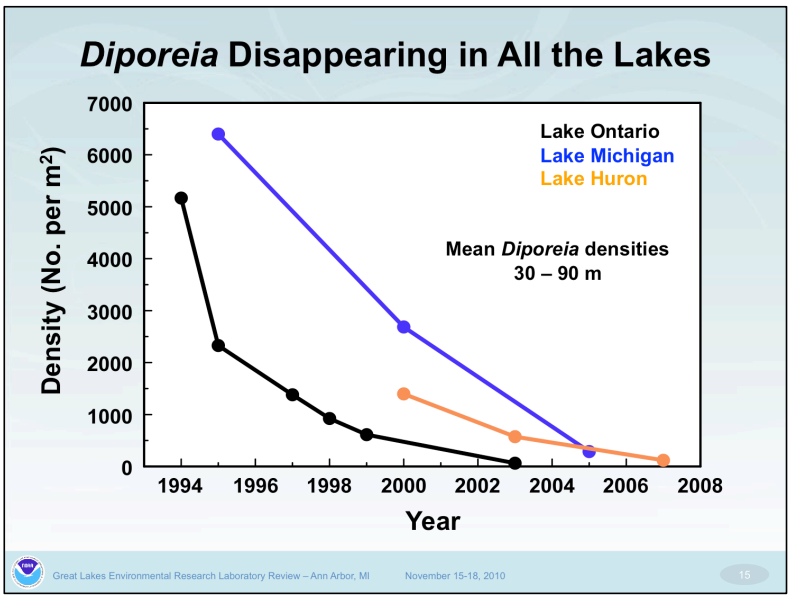
In addition to measuring abundance, we also measure biomass. It is the preferred unit for estimating filtering capacity and inputting food web models. Biomass also allows comparisons to other trophic levels such as fish. Often biomass tells a different story about trends as is apparent in our data set.



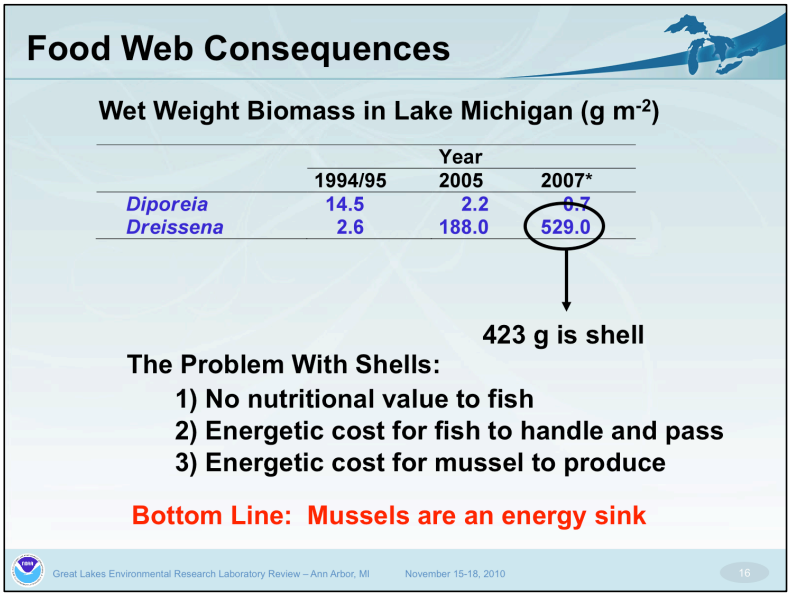
Based on the most recent lake-wide surveys, Quagga mussels are most abundant in Lake Michigan. Besides Lake Michigan, we also sample Lake Huron. Lake Ontario is taken from Watkins et al. (2007).



We documented the dramatic decline in *Diporeia* population in Lake Michigan from 1995-2000.



Lake Michigan and Lake Huron data is from the GLERL program, Lake Ontario data from Watkins et al. (2007).



*Estimated; we will get an update once samples taken in the 2010 survey are analyzed.

Scientific Leadership: Workshops

Dynamics of Lake Whitefish (*Coregonus clupeaformis*) and the Amphipod *Diporeia* spp. in the Great Lakes

Partners: Great Lakes Fish Commission, Ontario Ministry of Natural Resources

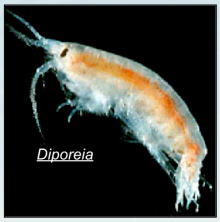
Recommendations: More flexible whitefish harvest models
Need to define cause of *Diporeia* decline
More collaboration between studies of upper and lower trophic levels

Trends observed in the benthic program have led to other research issues and two dedicated workshops. Workshops asked: Why is *Diporeia* declining; What is the impact on fish? Proceedings of both workshops have been published, and included with recommendations for future research:

Mohr, L. C., and Nalepa, T. F. 2005. Proceedings of a Workshop on the Dynamics of Lake Whitefish (*Coregonus clupeaformis*) and the Amphipod *Diporeia* spp. in the Great Lakes. Technical Report 66. Great Lakes Fishery Commission, Ann Arbor, MI. 310 pp.

Scientific Leadership: Workshops

Disappearance of the amphipod *Diporeia* spp. in the Great Lakes: Workshop summary, discussion, and recommendations



Partners: EPA- Great Lakes National Program Office
U. S. Geological Survey

Recommendations: Determine physiological health in Finger Lakes
Lab studies to define presence of toxic by-product
Use of new biochemical tools

Trends observed in the benthic program have led to other research issues and two dedicated workshops. Workshops asked: Why is *Diporeia* declining; What is the impact on fish? Proceedings of both workshops have been published, and included with recommendations for future research:

Nalepa, T. F., Rockwell, D. C., and Schloesser, D. W. 2006. Disappearance of the amphipod *Diporeia* spp. in the Great Lakes: Workshop summary, discussion, and recommendations. NOAA Technical Memorandum GLERL-136. NOAA, Great Lakes Environmental Research Laboratory, Ann Arbor, MI, 20 pp.

Data Users Within the Great Lakes Basin

Fish Managers:
Provides an understanding of why fish populations are changing so management priorities can be adjusted accordingly

Modelers:
The Great Lakes are now a dressenid (mussel) dominated system; models of energy or nutrient flow must have accurate estimates.

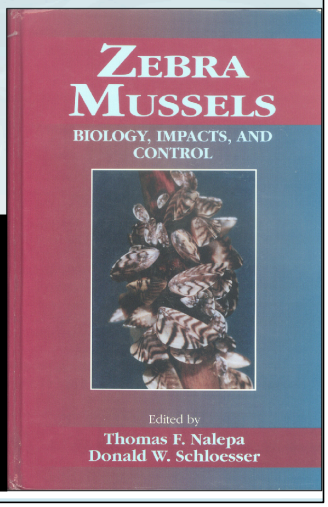
Policy-Makers:
Provides clear examples of the impacts of invasive species

Data Users Beyond the Great Lakes Basin

- Ecological impacts are of interest nationally and internationally

2010 Presentations (invited speaker):

- World Aquaculture Conference (San Diego)
- Great Lakes of the World Conference (Lake Tahoe)



(Invited speaker, only Great Lakes representative; invited every year, these are just the most recent invited talks outside the basin.)
Over past 5 years co-authored 4 papers with Russian and Polish colleagues.

Edited book: Zebra Mussels Biology, Impacts, and Control by Thomas F. Nalepa and Don Schloesser. Presently working on a second edition.

Partnerships

Current

- Mohamed Faisal (Michigan State): bacterial pathogens
- Tomas Hook, Marisol Sepuvelda (Purdue): condition, metabolic pathways
- David Jude (University of Michigan): diet composition
- Don Schloesser (U.S. Geological Survey): Saginaw Bay benthic trends

Long standing and On-going

- Great Lakes National Program Office-EPA: free ship use, data exchange
- Environment Canada: free ship use, data exchange

Change is On-going

Continue to consistently survey benthic populations in Lake Michigan and Lake Huron

- Lake-wide every five years in collaboration with other agencies
- Conduct more frequent surveys depending on the research issue

Current Unresolved Questions

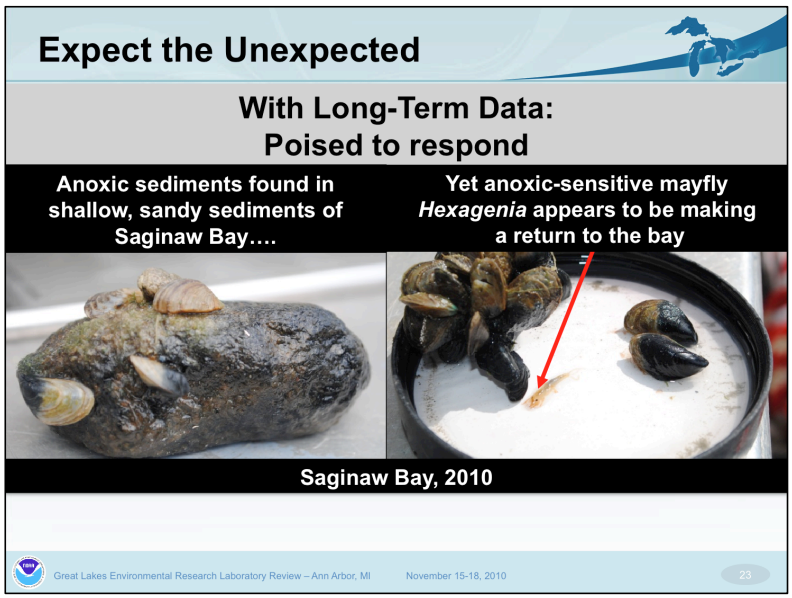
- When and at what level will Quagga mussel populations stabilize?
- Will *Diporeia* ever return?
- What will be the effect of other potential invaders?

Expect the unexpected

- Long-term trends surveys provide the basis for discovering unanticipated ecological change

Change continues to occur: mechanisms/stressors constantly changing.

Respond to emerging issues.



Photos courtesy of D. Kashian.